FINAL TECHNICAL REPORT
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Turbulence Fluxes
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Under the sponsorship of this grant a pitot tube for turbulence and eddy-correlation flux measurements from vertical profilers in the ocean was developed and deployed on four major field experiments. These have included experiments off the coast of northern California in May 1991, in British Columbia tidal channels in February 1990 and July 1992, and in a mountain lake in October 1994.

The development of the pitot tube led to the first critical assessment of mixing efficiencies in the ocean. These show a variability that may be due to the form of the initial instability, once again emphasizing the need to examine the physics of the instability process leading to the turbulence. The development also led to the introduction of new scalings for turbulent dissipation rate and eddy diffusivity based on the energy-containing scales of the turbulence - this is significant in that it does not require resolution of dissipation scales and eases the measurement requirements.

Measurements in mixed layers led to the discovery of the superadiabatic surface layer during convection. The analogy between the temperature structure of the convective boundary layers of ocean and atmosphere have been elucidated.

Turbulence measurements near the surface led to the community's acknowledgement that turbulence beneath a free surface cannot be predicted by standard wall boundary layer scaling. A theory of wave-turbulence interactions was developed as an attempt to explain the physics of the conversion of wave energy to turbulence which leads to the observed enhanced turbulence in the wave zone.

Measurements off northern California following local storms led to detailed observations of the decay of a near-inertial wave, from which we were able to quantify the energy loss to turbulence for the first time.

Small scale conductivity measurements using a new sensor led to the first estimates of salinity variance dissipation rate. This required quantifying the role of the temperature-salinity cross-spectrum to the conductivity spectrum, a factor not widely appreciated in our field.

LIST OF PUBLICATIONS

1990 Profiler measurements of vertical velocity fluctuations in the ocean. *J. Atmos. Oceanic Technol.*, **7**, 323–333. (J.N.Moum)

The quest for K_ρ - Preliminary results from direct measurements of turbulent fluxes in the ocean. *J. Phys. Oceanogr.*, **20**, 1980-1984. (J.N. Moum)

1992 The superadiabatic surface layer of the ocean during convection. *J. Phys. Oceanogr.*, **22**, 1221-1227. (A. Anis and J.N. Moum)

1994 Prescriptions for heat flux and entrainment rates in the upper ocean during convection *J. Phys. Oceanogr.*, **24**, 2142–2155. (A. Anis and J.N. Moum)

Decay of a near-inertial wave. *J. Phys. Oceanogr.*, **24**, 2334–2351. (D. Hebert and J.N. Moum)

1995 Surface wave-turbulence interactions: scaling $\epsilon(z)$ towards the sea surface. *J. Phys. Oceanogr.*, **25**, 2025–2045. (A. Anis and J.N. Moum)

Turbulence and mixing in the ocean: a review. *Rev. Geophys.*, suppl., 1385–1395. (D.R. Caldwell and J.N. Moum)

Mixing efficiencies in turbulent tidal fronts: a comparison of direct and indirect density flux estimates. *J. Phys. Oceanogr.*, **25**, 2583–2608 (A.E. Gargett and J.N. Moum)

1996 Efficiency of mixing in the main thermocline. *J. Geophys. Res.*, **101**, 12,057–12,069. (J.N. Moum)

Energy-containing scales of turbulence in the ocean thermocline. *J. Geophys. Res.*, **101**, 14,095–14,109. (J.N. Moum)

Vertical velocity from dynamic pressure sensors on vertical profilers. *Microstructure Sensors in the Ocean*, (J.N. Moum and D.R. Caldwell).

submitted:

Quantifying vertical fluxes from turbulence in the ocean. to *Oceanography* (J.N. Moum)

High-k conductivity gradient measurements: interpretation and estimation of salinity variance dissipation rate. to *J. Atmos. Oceanic Technol.*, (J.D. Nash and J.N. Moum).

A thermocouple probe for high speed temperature measurements in the ocean. to *J. Atmos. Oceanic Technol.*, (J.D. Nash, D.R. Caldwell, M.J. Zelman and J.N. Moum)